DOCUMENT RESUME

ED 307 105 SE 050 539

AUTHOR Cummins, Catherine L.; And Others
TITLE The Hidden Curriculum within the Teaching of Science and Its Relationship to Current Science Education Goals.
PUB DATE 89
NOTE 42p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, CA, March 27-31, 1989).
PUB TYPE Reports - Descriptive (141) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Educational Environment; *Educational Objectives; *Educational Theories; Elementary Secondary Education; *Hidden Curriculum; Incidental Learning; *Science Education; Science Teachers; *Socialization; Student Development; Teaching Methods; Values

ABSTRACT

Many science educators have called attention to the need for teachers to prepare all types of students for a rapidly changing, technological world. Curriculum theorists have called for changes in a hidden curriculum of science they described as class specific and presenting science as a consensus arrived at by positivistic methods. This paper discusses the hidden curriculum in science education, current goals of science education, and suggestions for addressing the hidden curriculum. A portion of this paper discusses the place of science, technology and society curricula. A list of 68 references is included. (CW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED307105

THE HIDDEN CURRICULUM WITHIN THE TEACHING OF SCIENCE AND ITS RELATIONSHIP TO CURRENT SCIENCE EDUCATION GOALS

Catherine L. Cummins
William F. Pinar
Ron Good

Department of Curriculum and Instruction
Louisiana State University
Baton Rouge, LA 70803

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Catherine Cummins

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

A paper presented at the 1989 annual meeting of the American Educational Research Association, San Francisco, California, March 27-31.

SE050539

BEST COPY AVAILABLE

THE HIDDEN CURRICULUM WITHIN THE TEACHING OF SCIENCE AND ITS RELATIONSHIP TO CURRENT SCIENCE EDUCATION GOALS

General Introduction

The hidden curriculum (previously also called the "unstudied curriculum", e.g., Overly, 1970) has been studied since the 1960's (Jackson, 1968). The hidden curriculum is a broad concept with many dimensions (Vallance, 1983). Snyder (1970) defined the hidden curriculum as "the covert frame of reference by which students organize and simplify the complexity and ambiguity" (Snyder, 1970, p. 141). Giroux and Penna (1977) defined the hidden curriculum as:

> Those unstated norms, values, and beliefs that are transmitted to students through the underlying structure of classrooms as opposed to the formally recognized and sanctioned dimensions of classroom experience. The hidden curriculum is based on a set of structural properties that promote social relations of education that are strongly hierarchial and authoritarian in nature. (p. 40)

The term hidden curriculum is often used in the context of the social relations in the classroom. The social relations of the classroom were summed up by Jackson (1968) as consisting of crowds, praise, and power. In the study of the hidden curriculum, these social relations are related to the needs and interests of societal institutions. The authoritarian nature of the social relations in schools was also discussed by Dreeben

(1970). These relations included the teachers' occupation in a organizational position according to their credentials, in which the teacher is in charge of a collective enterprise comprised of students in an involuntary association.

The hidden curriculum is studied for a variety of reasons including: Seeking what is learned in school, improving teaching methods, and revealing the connections between education and the larger social order (Martin, 1976). Snyder (1970) considered the hidden curriculum important in how students negotiate and adapt to four years of higher education and saw the hidden curriculum as providing rules for some of the games that students play in pursuing educational goals (Snyder, 1970, p. 12).

The hidden curriculum is most often discussed in the context of the teaching of social studies (e.g., Giroux & Penna, 1981; Keddie, 1971), although it is not restricted to that content area (Martin, 1976). Some authors suggest that certain social systems are taught as the "correct" system , whereas others are deemphasized or even rejected (e.g., Anyon, 1988; Apple, 1982; Apple & King, 1977; Friedenberg, 1970; Greene, 1983). Apple and King (1977) made the point that:

> The overt and covert knowledge found within school settings and the principles of selection, organization, and evaluation of this knowledge are valuative selections from a much larger universe of possible knowledge and collection principles...the

> institutionally patterned meanings that stand behind them can be scrutinized. (p. 31)

The choice of knowledge and of school environment can reflect the ideological presuppositions of the educators. Apple (1976) suggested three questions concerning how ideologies enter into school life:

> 1) How the basic day-to-day regularities of schools contribute to students learning the ideologies; 2) how the specific forms of curricular knowledge reflect these configurations; and 3) how these ideologies are reflected in the fundamental perspectives educators themselves employ to order, guide, and give meaning to their own activity. (p. 211)

We will try to address these questions as we examine the hidden curriculum in the teaching of science.

Hidden Curriculum in Science Education

The hidden curriculum of science education has been specifically addressed few times in the literature. Martin (1976) used a scheme in her discussion of the hidden curriculum that is useful in thinking about the hidden curriculum of the sciences. First, she said that the hidden curriculum is not restricted to social studies and should not be seen as a contrast between nonacademic learning and academic learning. She said that students come to conditions through learning called

"learning states" that consist of a "state" that a learner is in (e.g., believing or being interested, etc.) and the "object" of that state (e.g., a theory, a book, etc.). So a group of learning states constitutes a hidden curriculum. These learning states can be character traits (e.g., docility) or cognitive states (e.g., knowing), states of skill attainment, emotional states, attitudinal states, etc. To study a hidden curriculum in this way, "one must find out what is learned as a result of the practices, procedures, rules, relationships, structure, and physical characteristics, which constitute a given setting" (Martin, 1976, p. 139).

In early work on the hidden curriculum, Jackson (1970) suggested that a student will often say that they dislike a subject without being able to say why. He related this to our common experience of having knowledge but not remembering when we received it. He suggested that the hidden curriculum may have caused this dislike, and this result can be related to Martin's (1976) setting characteristics mentioned above. The characteristics of school settings and resultant learning states can be related to science teaching.

Snyder (1970) gave case studies of science students at M.I.T. and how they adapted to the hidden curriculum. Snyder's (1970) characteristics of the hidden curriculum are not restricted to science education alone. The students see the social relations in the classrooms consisting of an authoritarian professor who is to be distrusted and student interactions that

are competitive (Snyder, 1970, pp. 12 & 31). The hidden curriculum is seen to impart to students what particular performance is wanted from them (Snyder, 1970, p. 126). The students perceive the main tasks for successfully negotiating the hidden curriculum in higher education as: Reducing the environment into comprehensible parameters (Snyder, 1970, p. 44), selective negligence, setting one's inner clock by the institutional clock, and dedication to purposefulness (Snyder, 1970, p. 38). Students' responses to such tasks range from cynicism to helplessness (Snyder, 1970, p. 173).

Snyder (1970) portrayed grades, which affect the way students learn and feel about themselves, as a major stress in the hidden science curriculum. Students, especially in their first two years, perceive grades as motivators and as measures of self worth (Snyder, 1970, p. 30). Poor performance on tests was seen to stifle curiosity and wonder in the students and caused them to avoid intellectual risks (Snyder, 1970, p. 32). Thus, a characteristic of the hidden curriculum produced a result probably not desired by the faculty, because curiosity and wonder are vital personality characteristics of scientists. The students did not feel rewarded for the use of their imaginations (Snyder, 1970, p. 48).

Some students saw the hidden curriculum or agenda for what it was and addressed it directly (Snyder, 1970, p. 36). The hidden agenda was seen by these students as oversimplifying the problems and rewarding conformity rather than creativity. Other

students did not develop this sense of detachment and perceived the hidden curriculum as the game to master for completion of a degree. Such students talked positively about projects producing tangible results (Snyder, 1970, p. 33)

Snyder (1970, pp. 109-111) saw the hidden curriculum in higher education as affected by the ways in which colleges judge themselves, i.e., on the number of graduates who go on to higher degrees, publications, grants, prizes, etc. Seldom are these criteria related to the personal quality of life of the faculty or students, or to the effect that these criteria have on the learning process of students.

Slotnick, Kerbeshian, and Heller (1985), who studied the "implicit" curriculum of a medical school, found the underlying philosophy of this hidden curriculum to be allopathy. Allopathy referred to the teaching of physicians to treat pathologies but not to prevent them. Students were also not taught to understand why or how a treatment works. Thus, the hidden curriculum was more pragmatically oriented than the more theoretical formal curriculum.

Apple (1979, 1982) is one of the few scholars who has addressed the specific hidden curriculum of science at the elementary or secondary level. Apple (1982) tried to relate the form that a science curriculum takes to what he called technical control, which is "embedded in the physical structure" (p. 251) of a job and is based on management's control. Apple (1982) examined whether the curriculum is brought into closer

correspondence with industrial needs, and he concentrated on the form rather than the content of the curriculum. Apple (1982) related this correspondence to the control of capital and its impact on education. The concept of "deskilling" is important to technical control, because it involves subdividing labor so that a worker has less decision-making power and uses less specific skills. Apple (1982) used prepackaged curricular materials as examples of technical control. Of interest here is that he used one of the science curriculum packages as an example. These particular materials were developed by the American Association for the Advancement of Science (AAAS) and are called "Science - A Process Approach" (SAPA). SAPA is a process-centered science curriculum first developed in the 1960's. Apple (1982) believed that these prepackaged curricular forms enter schools because they are good business strategies. The act of planning is said to have been removed from the teacher, who Apple then sees as being deskilled. Apple (1982) stated that SAPA reduces knowledge to a set of appropriate behaviors and skills for the teacher and student, and he viewed this as a form of deskilling and technical control.

> The goals, the process, the outcome, and the evaluative criteria for assessing them are defined as precisely as possible by people external to the situation....this extends to the specification of even the exact words the teacher is to say. (Apple, 1982, p. 255)

Apple (1982) stated that teachers using SAPA are also being reskilled in skills of management while controlling students. These new skills include management of a classroom where the instruction is more individualized. Social relations among teachers are also changed because few interactions dealing with curricula are needed in schools using these prepackaged forms. This results in a loss of control for teachers in making curricular decisions.

The type of student created by these curricular reforms is described by Apple (1982) as "possessive." He sees this individual as a future part of the corporate economy in which a skilled technician is of value. The student is deskilled because the appropriate responses he/she is supposed to make are predetermined by the curriculum designers. Apple (1982) sees SAPA as fragmenting knowledge into a set of skills and knowledge that would serve technical interests. Apple (1982) addresses the circumstances preceding the development of SAPA. This curriculum and others similar to it were developed specifically to create more scientists (Hofstein & Yager, 1982; Koballa, 1985; Kyle, 1985) in response to the Soviet launch of Sputnik. Apple (1982) believed that these curricula remain in force to benefit the productivity and efficiency of the State.

However, Apple (1982) does not address the point that many elementary teachers have poor science backgrounds (Hodson, 1988; Koballa, 1985) and if these packages enable them to teach a subject they otherwise would not be able to, then SAPA and

similar programs could be seen as empowering to teachers. Also, science education is not defined as any one curricular package (e.g., SAPA). There are many such packages, and SAPA is considered one of the most structured (Carin & Sund, 1985). Therefore, criticism of SAPA cannot necessarily be extended to a general criticism of science education.

The type of curriculum form that Apple (1982) described is not common in public schools (Kyle, 1985; Pratt, 1981). To appreciate different forms of science teaching, the dual nature of science must be discussed. Science consists of products and processes (e.g., Carin & Sund, 1985; Duschl, 1988), and either or both can be emphasized during teaching. An interesting result relating science teaching and curricular form to social class can be found in Anyon's (1980) work. She provided examples of school work in science from different schools in different social class communities. Although science instruction was not the main topic of the work, the information presented was insightful when related to Apple's (1982) work. The types of science instruction found in Anyon's (1980) descriptions can be divided into product-centered and process-centered by social class type. Anyon (1980) found that product-centered approaches were used in schools of the lower social classes. For example, science in a working-class school consisted of copying the teacher's sentences, which were restatements of the textbook. The teacher sometimes performed a demonstration, which was called an experiment, and the students later copied down what the teacher told them that

they had "found". Science projects consisted merely of choosing a project from the teacher's file and then following the steps given to complete it. The teacher even said that the card "tells them exactly what to do, or they couldn't do it" (p. 75). Anyon (1980) did not describe the science classes in detail in the middle-class school, but noted that learning was characterized by finding answers in books or by listening to the teacher. Science projects were described as not requiring creativity. Thus, students in these schools exist in a learning state (sensu Martin, 1976) of passively receiving scientific knowledge of the teacher's choosing from the textbook. This type of instruction seems to be the same as Apple (1979) described. The students learn science as a static body of knowledge in which they do not participate.

The professional school that Anyon (1980) studied used a process-centered science approach called Elementary Science Study (ESS) that is somewhat similar to SAPA. ESS is also a product of the curriculum reforms of the 1960's and includes teacher's guides with suggested activities and prepackaged material kits. ESS is less structured than SAPA, however (Carin & Sund, 1985). The professional school teacher knew about the researched benefits of "hands-on" science. Anyon (1980) found the same science program, ESS, in an executive elite school in which development of analytical powers was highly valued. Students wrote lab reports on experiments that they performed. Thus, these students were active generators of knowledge. Science

discussions incorporated current societal topics related to science. The students learned by experience and not by relying solely on the authority of the teacher or textbook.

Anyon (1980) concluded that the children in the upper classes are receiving materials, skills, and means of expression not presented to the lower classes:

> Differing curricular, pedagogical, and pupil evaluation practices emphasize different cognitive and behavioral skills in each social setting.... In the contribution to the reproduction of unequal social relations lies a theoretical meaning and social consequence of classroom practice. (p. 90)

The three questions (found above) from Apple's (1976) work can be applied here. The day-to-day science lessons differ between the schools of the Anyon's study. The forms of the curricula differ in that they become increasingly process- and student-centered in the upper social class schools. The teachers of the lower class students give meaning to their practice by saying that it is the only way that the students will learn. In contrast, the teachers of the upper classes feel that science education research supports their use of innovative curricula. The state of the learner (gensu Martin, 1976) shifts from passive in the lower classes to active in the upper. However, learning these same skills are the activities that Apple (1982) described as technical control.

Several trends can be seen in the teaching of science as traditionally and most commonly taught today. Science is most often seen as a body of knowledge (Apple, 1979) that is simply to be passed from teacher to student (Duschl, 1988; Kyle, 1985; Staver & Bay, 1987). This body of knowledge is most often represented by textbooks, the majority of which consists of academic content seldom related to societal or to personal concerns (Staver & Bay, 1987). These textbooks, especially in biology, are also subject to manipulation by nonscientific interest groups (Apple, 1984; Skoog, 1984). This type of instruction rejects the dual nature of science as both a product and a process. The product is emphasized at the expense of the process of doing science. The process of science, inquiry, is absent or severely limited in most texts (Staver & Bay, 1987).

There are many reasons for teaching science in this way. First, teachers are often not truly qualified to teach the content areas that they are forced to teach (e.g., Hodson, 1988; Koballa, 1985). In this case, it is much less threatening to teach by repeating textbook statements and to test for the information learned than to teach by understanding these concepts and how they are derived. Second, teachers may have a background to teach the process of science, but they may not have the facilities and/or the budget to do so. Science activities usually require equipment, which may not be available. Third, teachers may be qualified and have the resources, but they may be receiving pressure to limit the amount of process-centered

science taught. The "Back to Basics" movement has deemphasized science in general in favor of the "three R's" (Brodinsky, 1977; Pratt, 1981). Even when science is taught, many teachers perceive that teaching science in a process-centered way will not prepare students properly for the standardized achievement tests and other measures that seem to be so important (Koballa, 1985). This perception, however, is not backed by research (e.g., Bredderman, 1982; Kyle, 1985; Pratt, 1981; Shymansky, Kyle, & Alport, 1983).

Apple (1979) lumped process- and product-centered science curricula together and said that they both portray science as a body of knowledge. He felt that to present science in this way reflects a deliberate avoidance of conflict. Apple (1979) characterized science as a "community of scholars...pursuing projects in the world" (p. 88), and he saw this community in continual interpersonal conflict. In contrast, science is presented in schools as a consensus (Apple, 1979).

Gordon (1984) presented views regarding the hidden curriculum of science that are similar in some ways to those of Apple (1979). Like Apple (1979), Gordon (1984) also pointed to the absence of conflict in science teaching and then went on to give an insightful discussion describing the image of science transmitted by the hidden curriculum. He characterized this image of science as the "bucket image" (taken from Popper, 1972). This image was described by Gordon (1984) as:

Scientific truth exists "out there." It consists of a

> collection of facts. We today know some of them. At one time, fewer were known and in the future more will be known. Scientific knowledge accumulates steadily. Generally there are no revolutions in science. It rarely occurs that a statement believed to be true is discovered afterward to be untrue. The facts that make up scientific truth are facts about things that really exist in the world....the reason they are unknown is that the scientists haven't gotten around to discovering them. When they have the time they will discover them, because discovering these facts isn't problematic, at least not for the scientists, who are clever people. We know that scientific explanations are true because they <u>make sense</u> (italics in original) (i.e., one sees how things work). (p. 372)

Again this view is very similar to the body of knowledge concept of science (Apple, 1979). Like Anyon (1980), Gordon (1984) observed science classes and then related what he observed to the hidden curriculum literature.

Gordon (1984) described what can be considered traditional science lessons in which he saw students progressing to predetermined results. One problem with this depiction is that Gordon (1984) concentrated on physics and chemistry teaching. This became problematic in his characterization of science lessons as having "facts" that are directly observable. Granted, most chemistry and physics lessons probably are like this, but

Gordon (1984) did not address how much inference is involved in science activities in the life sciences. Indeed, it is life science that is more available to most students, because physics and chemistry are usually offered only to college-bound students late in their high school careers. This bucket image may not be transmitted as strongly in a life science classroom, especially where inquiry-oriented and open-ended activities are used in science teaching (see Suggestions section).

In his discussion, Gordon (1984) suggested that the bucket image of science is not resisted by students, and that this part of the hidden curriculum is accepted unquestioningly. This acceptance was important to Gordon (1984) because this view of science was central in developing the students' technological consciousness. Gordon (1984) stated that the technological consciousness involved perceptions of progress, reasonableness of explanation, and experts. The bucket image of science portrays progress as quantitative and cumulative without an awareness of values. Reasonableness of explanation is based on common sense and mechanistic analysis. Scientific experts are seen as the final authority. This image of science rejects a critical view of scientific processes, products, or scientists themselves. Gordon (1984) made the interesting point that if we truly want this particular technological consciousness for our technological society then we can quit worrying about scientific literacy, because students are literate based on that criterion. However, if students are to relate science to social issues, this part of

the hidden curriculum regarding the image of science must be addressed. Gordon (1984) cautioned that changing curricular materials does not guarantee changing the nature of the classroom. Teachers would also have to change their philosophy of science as it is presented to the students.

The philosophical background of teachers is both poor and out-dated (Hodson, 1988). The general nature of the type of science traditionally taught can be described as positivistic (Apple, 1979; Duschl, 1988). Positivism (e.g. Ayer, 1946, 1959) characterizes science as objective and value-neutral, with standards of validity and verification. Science taught in this way presents an authoritarian view of science (Duschl, 1988). Many of the curricular materials and the method books stress objectivity and structured disciplines (e.g., Shayer & Adey, 1981). Positivism, with its exclusive interest in prediction and control, will not allow students to develop the political and ethical questions that provide the basis of educational theory, development, and evaluation (Apple, 1979; Giroux, 1983). Apple (1979) and Gordon (1984) felt that to teach science in the positivistic tradition without discussion of the argumentation involved hides controversy from students and, therefore, is part of the hidden curriculum.

Analysis of Current Goals for Science Education

There are now discussions in the science education community regarding the teaching of science in a way that students can

understand science as a human activity and cultural phenomenon (e.g., Christianson, 1982; Staver & Bay, 1987). Indeed, there is a movement to establish new goals for science education. The most organized part of this movement toward new goals emphasizes instruction about the interactions of science, technology, and society (e.g., Bybee, 1985; Hofstein & Yager, 1982; Yager, 1985). This emphasis on science, technology, and society is called STS. These new goals are said to have been developed to produce a scientifically literate citizenry, and suggest that science teaching should address current societal problems and their relationship to science and technology (Hofstein & Yager, 1982; Koballa, 1985; Kyle, 1985). These suggestions are very similar to those of Apple and other curriculum theorists. However, the science educators do not seem to address the literature on the hidden curriculum and instead state that they are addressing current societal needs. Whether they are intended to or not, these new goals do address the hidden curriculum of the product-centered, positivistic approach to science education as well as the authoritarian structure of the classroom. However, in our opinion, STS does not offer a suitable alternative if its goal is to use STS issues as <u>organizers</u> for the science curriculum (e.g., Hofstein & Yager, 1982; Yager, 1985).

Hofstein and Yager (1982) stated their rational for implementing the use of social issues as organizers in the science curriculum:

> ...it helps delineate content that can be useful for

> improving the quality of life. Information with the potential for utilization will be included. This means that knowledge considered fundamental to the discipline in the past may be omitted from the curriculum. (p. 542)

These statements immediately raise several questions, which we will use to analyze the hidden curriculum of STS. First, who decides what content improves the quality of life for a diverse student population, and how do they decide? Second, in an ever-changing world, how do we know ahead of time what knowledge will be useful? Third, does a discipline make sense when taught without knowledge that is considered fundamental to it? For instance, can we decide that evolution need not be taught even though it is fundamental to biology but may not be considered utilitarian? Fourth, does this type of curriculum present an accurate view of science? Fifth, because STS is structured around societal topics, who will pick the topics for discussion, and which topics will be omitted? Sixth, how will STS portray the relationship between social ethics and science? Such questions open up a pandora's box for manipulation and control of the curriculum by nonscientific special interest groups such as creationists (Good, Kromhout, Lawson, & Renner, 1985; Good, Herron, Lawson, & Renner, 1985; Kromhout & Good, 1983).

Understanding how science and technology and society interact is a worthy goal, one that we support and find extremely challenging. However, we believe that social issues must not

replace the scientific disciplines as "organizers" of science curricula (Good, Kromhout, Lawson, & Renner, 1985; Good, Herron, Lawson, & Renner, 1985) as suggested by Hofstein and Yager (1982). Science as a human endeavor and as a body of knowledge is quite different than the study of the interactions of science technology and society. These interactions are clearly social science issues.

We agree that knowledge about STS issues is useful to students, but science education in U.S. schools is the study of physics, chemistry, biology, and the earth sciences. When STS is proposed as the organizational structure for the science curriculum, as in physics or biology, STS is being masqueraded as science. Living in Louisiana as we do, we have seen the dangers of movements masquerading as science (e.g., Creation Science) and how they can challenge what is described as science in our schools. Social issues change as political, economic, and other social factors change, sometimes precipitously (Kromhout & Good, 1983). It is not clear that learning about today's social/technological issues will prepare students to make decisions about future technologies. It is important to help students understand that science, as a way of knowing, seeks to learn how nature works.

Considerable support exists for the STS theme (Bybee, 1985, 1987). STS is often promoted as the way to help students in science classes use their knowledge of science to solve society's problems. The implicit message of the curriculum here refers to

the function of science. While we agree that social issues can be used to increase the apparent relevancy of science for many students, it is misleading to suggest that science exists for the purpose of curing the ills of society. Decisions to use or misuse the products of science and technology are political decisions driven largely by our economic system, although it is now clear that our economic system is more and more driven by a world economy.

Apple (1986) used the term "slogan systems" to refer to particular types of curricula. Apple stated that slogan systems must be charming, vague enough to include persons who disagree on many other things, and specific enough to offer practitioners something immediately. Using social issues as the organizers for science curricula, the apparent goal of many proponents of STS (e.g., Hofstein & Yager, 1982), seems to fit nicely on all three counts. STS is charming in that nearly everyone wants to see their concerns about air quality, land use, water resources, world hunger, etc. resolved as simply as possible. STS is vague enough to avoid the complexities involved with all important social issues. Finally, STS is specific enough to allow for curriculum development for and by practitioners that seems to be addressing the social concerns.

Slogan systems offer simplistic solutions. Difficult social problems such as those listed in the Science-Technology -Society Framework (Hickman, Patrick, & Bybee, 1987), are highly resistant to simplistic solutions; otherwise we would not have world

hunger, pollution of natural resources, threat of nuclear destruction, and the many other social issues that can be related to science and technology. We are not saying these are unimportant problems, or that they should not be discussed in schools, only that solutions to these problems are not scientific by nature.

In an STS-organized curriculum, the social issues of the day (because of their complex, value-laden nature) cannot be tested directly in the laboratory as can many assertions in the experimental sciences. A "science" curriculum organized around social issues would offer relatively few opportunities for verification through experimentation compared to a science curriculum consisting mostly of assertions about our natural environment. Thus, student's experiencing the process of science would be diminished while more product-centered material organized the curriculum. The STS product would be different from the product we have now, but would be further removed from the study of science.

Earlier we discussed the hidden curriculum and the role of authority in the classroom (e.g., Snyder, 1970). The locus of authority in science and in science classrooms that are centered around the laboratory as verifier, is on the results of probes into nature. When agreement between theory and experiment is good, the student or scientist more readily accepts assertions about the nature of things, or at least is obligated to do so. Students learn that assertions about the nature of things must be

verified experimentally. When direct verification through personal data collection in the classroom is not possible due to lack of proper equipment, etc., then others' experimental data must be substituted as verification for the assertions. The important point here is that the locus of authority shifts away from experimental verification toward the teacher's authority, toward that of the textbook, or toward more democratic means such as majority rule. While science has been demonstrated to exhibit social and political dimensions, it does not proceed primarily politically, and socially (Kuhn, 1970).

Science as a way of knowing is not personally authoritative or fundamentally democratic. The individual scientist uses experimental evidence rather than public relations and marketing techniques to convince his/her colleagues that his/her ideas are worth considering. While studies of the scientific process do reveal interesting insights into the personal and social aspects of scientists and their work, it is clear that the actual evidence remains the mainstay of decision making about the nature of things (e.g., Gould, 1988; Kuhn, 1970; Lewin, 1988).

Whether intentional or not, it is inevitable that a curriculum focussed on the interactions of science, technology, and society will shift the emphasis on decision making from experimental evidence toward other grounds. How people choose to treat others and their environment usually has far less to do with their knowledge of science than with other factors.

Our position on this part of the hidden curriculum should not be taken as support for positivism, competition over cooperation in the classroom, or a skepticism regarding the significance of the sociology of science. As might be expected with multiple authors of a paper such as this, we agree on many issues and disagree on some others. We do agree that the natural sciences focus their attention on agreement between assertions and results of probes into the natural world rather than on the social issues of the day. The ways of knowing associated with this focus on nature are largely different than ways of knowing associated with the study of interactions among science, technology, and society. Because of these differences, classrooms that use curricula organized around social issues will necessarily shift the authority in decision making away from hypothesis-experiment paradigm toward other more "socially-modulated" forms of decision making.

Suggestions for Addressing the Hidden Curriculum

What can we do to disclose elements of the hidden curriculum; those elements that instill beliefs, attitudes, values, or patterns of behavior which are undesirable (Martin, 1976)? How can we attempt to address this hidden curriculum in the sciences to make it more truly reflect a contemporary and complex view of the process of science? Giroux and Penna (1977) offer some excellent insights into process-centered science teaching even though it is offered regarding the teaching of

socialism:

> When process is divorced from content even the most radical content will fail to politicize students... there is more than enough evidence to suggest that what students learn in the classroom is governed less by the nature of the content they are taught than by the underlying structural relations that shape their behavior. (p. 40)

Giroux and Penna (1977) went further and said that if the relationship between process and content is not made explicit, then the pedagogical model is only reifying. While Apple (1979) suggested that prepackaged, process-centered science curricula do not allow students to study the nature of conflict in science, he failed to appreciate that the process-centered curricula do allow students to deal with conflict at some level, especially when their results differ from those of their colleagues. This will be further discussed later in the context of group work.

Certain writers (e.g., Aoki, 1988; Macdonald, 1988; Whitson, 1988) have already suggested models of organizing curricula (mostly addressed to social studies), which could be adapted to science curricula to lessen the positivistic tendencies. Apple (1979) and Hodson (1988) suggested emphasizing the personal history of science, with special reference to the conflict within it. The challenge will be to keep the process-centered and inquiring nature of science intact while not stressing positivistic methods (cf. Bruner, 1970; Schwab, 1978). Some

science educators are directly addressing this as an issue of philosophical method (Duschl, 1988, Hodson, 1988).

Teaching science as a human activity also implies introducing scientists as fallible beings with personalities, ambition, ethical conflicts, etc. (e.g., Apple 1979; Carin & Sund, 1985; Christianson, 1982; Gould, 1981). This enables the student to interpret scientific achievements in terms of the human and social forces that formed them (Christianson, 1982) and to examine ways that science acts on those human and social forces (Hofstein & Yager, 1982; Koballa, 1985; Staver & Bay, 1987). Suggestions by Duschl (1988) and Hodson (1988) could address the bucket image of science as described by Gordon (1984). Duschl (1988) suggested consulting historians, philosophers, and sociologists of science for their input in new curriculum design. Hodson (1988) stressed that teachers must also be trained in current philosophy of science.

If a part of the hidden curriculum is defined as the social relations of the classroom, various forms of science curricula suggest an emphasis on different types of social relations. The "verification through experimentation" part of science demands an emphasis on laboratory work in school science. Whether the ideas being tested are the students' or others', the authority in this case is neither the teacher nor the text, but the results of the probes into nature. Giroux and Penna (1977) gave some suggestions for altering the structural properties of the classroom to be "unalienating" to students and less authoritarian

for teachers. These suggestions can be applied to science teaching as well as to social studies; they include: Letting students make choices about what they learn, analyzing classroom relations in relation to society, minimizing extrinsic rewards, using self-paced learning, developing student proctor roles for student leadership, and incorporating group work. To counteract the negative effects of the hidden curriculum, Snyder (1970, pp. 196-197) suggested designing instruction with intrinsic motivation and deemphasizing competition and grades by letting students participate in the grading process. He advocated more use of hands-on science. Most of these ideas are listed as advantages of a current process-centered science teaching approach called "guided discovery" or "guided inquiry " (e.g., Carin & Sund, 1985; Staver & Bay (1987).

Giroux and Penna's (1977) suggestion to incorporate group work is especially interesting because this is a currently active area of research in science education. The type of grouping receiving the most attention is "cooperative grouping" (e.g., Johnson & Johnson, 1982). This grouping is unlike ability grouping as described by some authors who analyze the hidden curriculum (e.g., Barr & Dreeben, 1983). Cooperative grouping should be heterogeneous and not based on similar levels of ability. Johnson and Johnson (1982) and Johnson, Johnson, Holubec, and Roy (1984) reported that cooperative grouping reduces the individuality and competition of traditional classrooms (two issues also of concern to many writers who

discuss the hidden curriculum); and this reduction results in improvement in achievement, critical thinking, attitudes toward science, attitudes of students toward each other, self-esteem, psychological health, and social skills. Group work also allows for constructive conflict (Johnson & Johnson, 1982, 1985). This could be seen as a more personal experience of scientific conflict than Apple (1979) described. Other authors suggested that the groups be structured to allow each student to have an active role (Jones, 1984). The ideal grouping method for minimizing the authoritarian nature of the hidden curriculum would be to allow students to form their own groups and designate group roles. If an open inquiry approach were used (e.g. Hodson, 1988; Staver & Bay, 1987) then the group could work on a problem of their own choosing. Such investigation groups allow students to work as a scientific research team would work. This type of classroom structure has been suggested for effective teaching by many science educators (e.g. Welch, 1985), although Tingle and Good (1989) found that group work, by itself, does not ensure better achievement, attitudes toward science, etc. It is likely that when used wisely in conjunction with other classroom methods, cooperative grouping will lead to certain outcomes considered beneficial by many science educators. We caution against viewing cooperative grouping as a panacea that by itself will lead to the solution of important problems.

Another way to address the traditionally structured setting of the classroom while emphasizing the process of science is to

literally take science education outside the classroom. Science is an ideal subject to be taught in informal settings, yet this is not done in most cases (Welch, 1985). Learners in these situations have less time constraints and fewer coercive forces or traditional evaluation techniques (Koran & Shafer, 1982). There is no substitute for direct experience of a scientific topic. Going outside and performing an ecological survey will be a much greater source of learning than will reading about one. Many parks and museums now have interpretive/educational specialists who aid teachers in the using experience (e.g., Silver, 1987). Informal settings allow students with a variety of backgrounds and abilities to learn in ways that may be more suitable to them than would a textbook and lecture (Koran & Shafer, 1982).

Conclusion

Many science educators (e.g., Carin & Sund, 1985; Hofstein & Yager, 1982; Koballa, 1985; Kyle, 1985; Snyder, 1970, p. 137; Staver & Bay, 1987) have called attention to the need for science education to prepare all types of students for a rapidly changing, complex technological world. Science educators have called for changes in the curriculum to reflect these new goals.

Curriculum theorists have called for changes in a hidden curriculum of science they described as class-specific (Anyon, 1980) and as presenting science as a consensus arrived at by

positivistic methods (Apple, 1979; Gordon, 1984). Unfortunately, neither set of scholars often cites works from the other set. Identifying and disclosing the hidden curriculum in science education will be essential. Dialogue by both science educators and curriculum theorists will be necessary to this work.

Disclosing the hidden curriculum, correcting positivism, and explicating the relations among technology, science, and society must be embedded in science curricula. The conflict, interpersonal, political, and intellectual, evident in the history of science can illustrate essential aspects of scientific discovery. However, such political-historical issues must illustrate science, not vice versa. The landmark scholarship of Thomas Kuhn (1970) and his students (cf. Brown, 1988; Richards, 1988) support this emphasis.

Adjudication between positivists and social radicals will be necessary. Positivism must be identified and critiqued from epistemological perspectives associated with complex, contemporary histories and philosophies of science. Social/technological developments can be included as they illustrate processes of scientific discovery and application. However, science must not be replaced by social studies, as the STS movement risks. We propose a "middle way" in science education, one that:

1) Acknowledges technology, science, and society as meaningfully interrelated and as historical, gendered, and political phenomena (Richards, 1988; Morantz-Sanchez, 1985).

2) Acknowledges process or inquiry -- understood as those procedures internal to science -- as a fundamental element of science education.

3) Acknowledges fact acquisition as an essential aspect of a science education.

We propose to keep fact acquisition and process in dynamic interrelation, employing as appropriate, historical and social issues to illustrate them. The curricular center of science education remains, however, science and not social studies. Phenomenological and political curriculum theory (Pinar, 1988) may assist in this future labor. Conceived carefully, the hidden curriculum of the epistemological right and left can be avoided while their legitimate contributions can be incorporated into the everyday teaching of science.

Acknowledgements

We appreciate the careful reading and comments on a previous version of this paper by J.V. Remsen. C. L. Cummins received financial support from the Kappa Kappa Gamma Graduate Fellowship during the preparation of this paper.

References

Anyon, J. (1980). Social class and the hidden curriculum of work. Journal of Education, 162, 67-92.

Anyon, J. (1988). Schools as agencies of social legitimation. In W. F. Pinar (Ed.), Contemporary curriculum discourses (pp. 175-200). Scottsdale, AZ: Gorsuch Scarisbrick.

Aoki, T. T. (1988). Toward a dialectic between the conceptual world and the lived world: Transcending instrumentalism in curriculum orientation. In W. F. Pinar (Ed.), Contemporary curriculum discourses (pp. 402-416). Scottsdale, AZ: Gorsuch Scarisbrick.

Apple, M. W. (1976). Curriculum as ideological selection. Comparative Education Review, 20, 209-215.

Apple, M. W. (1979). The hidden curriculum and the nature of the conflict. In M. W. Apple, Ideology and curriculum (pp. 82-104). Boston: Routledge & Kegan Paul.

Apple, M. W. (1982). Curricular form and the logic of technical control: Building the possessive individual. In M. W. Apple (Ed.), Cultural and economic reproduction in education (pp. 247-274). Boston: Routledge & Kegan Paul.

Apple, M. W. (1984). The political economy of text publishing. Educational Theory, 34, 307-319.

Apple, M. W. (1986). Teachers & texts: A political economy of class & gender relations in education. New York: Routledge.

Apple, M. W., & King, N. R. (1977). What do schools teach? In R. H. Weller (Ed.), Humanistic Education (pp. 27-63). Berkeley: McCutchan.

Ayer, A. J. (1946). Language, truth and logic (2nd ed.). London: Victor Gollancz.

Ayer, A. J. (Ed.). (1959). Logical positivism. Glencoe, IL: The Free Press.

Barr, R., & Dreeben, R. (1983). How schools work. Chicago: Univ. of Chicago Press.

Bredderman, T. (1982). The effects of activity-based science in elementary schools. In M. B. Rowe (Ed.), Education in the 80's: Science (pp. 63-75). Washington, D.C.: National Education Association.

Brodinsky, B. (1977). Back to the basics: The movement and its meaning. Phi Delta Kappan, 58, 522-527.

Brown, T.M. (1988). How fields change: A critique of the "Kuhnian" view. In W. F. Pinar (Ed.), Contemporary curriculum discourses (pp. 16-30). Scottsdale, AZ: Gorsuch Scarisbrick.

Bruner, J. S. (1970). The importance of structure. In J. K. Davis (Ed.), Man in crisis: Perspectives on the individual and his world. Glenview, IL: Scott, Foresman and Co.

Bybee, R. W. (Ed.). (1985). Science Technology Society: 1985 yearbook of the national science teachers association. Washington, DC: National Science Teachers Association.

Bybee, R. W. (1987). Science education and the science-technology-society (S-T-S) theme. Science Education, 71, 667-683.

Carin, A.A., & Sund, R. B. (1985). Teaching science through discovery. Columbus, OH: Charles E. Merrill.

Christianson, D. (1982). Understanding science as a cultural phenomenon -- mission for the 80's. In M. B. Rowe (Ed.), Education in the 80's: Science (pp. 17-24). Washington, D.C.: National Education Association.

Dreeben, R. (1970). Schooling and authority: Comments on the unstudied curriculum. In N. V. Overly (Ed.), The unstudied curriculum: Its impact on children (pp. 85-103). Washington, D.C.: Association for Supervision and Curriculum Development.

Duschl, R. A. (1988). Abandoning the scientistic legacy of science education. Science Education, 72, 51-62.

Friedenberg, E. Z. (1970). Curriculum as educational process: The middle class against itself. In N. V. Overly (Ed.), The unstudied curriculum: Its impact on children (pp. 16-26). Washington, D.C.: Association for Supervision and Curriculum Development.

Giroux, H. (1983). Teacher education and the ideology of social control. In H. Giroux, & D. Purpel (Eds.), The hidden curriculum and moral education: Deception or discovery? (pp. 403-425). Berkeley: McCutchan.

Giroux, H., & Penna, A. (1977). Social relations in the classroom: The dialectic of the hidden curriculum. Edcentric, 40:41, 39-47.

Giroux, H., & Penna, A. (1981). Social education in the classroom: The dynamics of the hidden curriculum. In H. Giroux, A. N. Penna, & W. F. Pinar (Eds.), Curriculum & Instruction (pp. 209 - 230). Berkeley: McCutchan.

Good, R., Herron, J. D., Lawson, A. E., & Renner, J. W. (1985). The domain of science education. Science Education, 69, 139-141.

Good, R., Kromhout, R., Lawson, A. E., & Renner, J. W. (1985). Science education: Definitions and implications for research. Paper presented at the annual meeting of the National Association for Research in Science Teaching, French Lick Springs, IN.

Gordon, D. (1984). The image of science, technological consciousness, and the hidden curriculum. Curriculum Inquiry, 14, 367-400.

Gould, S. J. (1981). The mismeasure of man. New York: W. W. Norton.

Gould, S. J. (1988, January). An essay on a pig roast. Natural History, pp. 14-25.

Greene, M. (1983). Introduction. In H. Giroux, & D. Purpel (Eds.), The hidden curriculum and moral education: Deception or discovery? (pp. 1-5). Berkeley: McCutchan.

Hickman, F. M., Patrick, J. J., & Bybee, R. W. (1987). Science/technology/society: A framework for curriculum reform in secondary school science and social studies. Boulder, CO: Social Science Education Consortium.

Hodson, D. (1988). Toward a philosophically more valid science curriculum. Science Education, 72, 19-40.

Hofstein, A., & Yager, R. E. (1982). Societal issues as organizers for science education in the 80's. School Science and Mathematics, 82, 539-547.

Jackson, P. W. (1968). Life in classrooms. New York: Holt, Rinehart and Winston.

Jackson, P. W. (1970). The consequences of schooling. In N. V. Overly (Ed.), The unstudied curriculum: Its impact on children (pp. 1-15). Washington, D.C.: Association for Supervision and Curriculum Development.

Johnson, D. W., & Johnson, R. (1985). Classroom conflict: Controversy versus debate in learning groups. American Educational Research Journal, 22, 237-256.

Johnson, D. W., Johnson, R. T., Holubec, E. J., & Roy P. (1984). Circles of learning: Cooperation in the classroom. Alexandria, VA: Association for Supervision and Curriculum Development.

Johnson, R. T., & Johnson, D. W. (1982). What research says about student-student interaction in science classrooms. In M. B. Rowe (Ed.), Education in the 80's: Science (pp. 25 - 37). Washington, D.C.: National Education Association.

Jones, R. M. (1984). Using inquiry task groups in elementary science. Paper and workshop presented at the area convention of the National Science Teachers Association, Beaumont, TX.

Keddie, N. (1971). Classroom knowledge. In M. F. D. Young (Ed.), Knowledge and control: New directions for the sociology of education (pp. 133-160). London: Collier Macmillan.

Koballa, T. R. (1985). Goals of science education. In D. Holdzkom, & P. B. Lutz (Eds.), Research within reach: Science Education (pp. 25-39). Washington, D. C.: National Science Teachers Association.

Koran, J. J., & Shafer, L. D. (1982). Learning science in informal settings outside the classroom. In M. B. Rowe (Ed.), Education in the 80's: Science (pp. 52-62). Washington, D.C.: National Education Association.

Kromhout, R., Good, R. (1983). Beware of societal issues as organizers for science education. School Science and Mathematics, 83, 647-650.

Kuhn, T. (1970). The structure of scientific revolutions (2nd ed.). Chicago: University of Chicago Press.

Kyle, W. C. (1985). Curriculum development projects of the 1960's. In D. Holdzkom, & P. B. Lutz (Eds.), Research within reach: Science Education (pp. 3-24). Washington, D. C.: National Science Teachers Association.

Lewin, R. (1988). Conflict over DNA clock results. Science, 241, 1598-1600.

Martin, J. (1976). What should we do with a hidden curriculum when we find one? Curriculum Inquiry, 6, 135-151.

Macdonald, J. B. (1988). Curriculum, Consciousness and Social change. In W. F. Pinar (Ed.), Contemporary curriculum discourses (pp. 156-174). Scottsdale, AZ: Gorsuch Scarisbrick.

Morantz-Sanchez, R. M. (1985). Sympathy and Science: Women physicians in American medicine. New York: Oxford University Press.

Overly, N. V. (Ed.). (1970). The unstudied curriculum: Its impact on children. Washington, D.C.: Association for Supervision and Curriculum Development.

Pinar, W. F. (Ed.). (1988). Contemporary curriculum discourses. Scottsdale, AZ: Gorsuch Scarisbrick.

Popper, K. R. (1972). Objective knowledge. London: Oxford University Press.

Pratt, H. (1981). Science education in the elementary school. In N. C. Harms & R. E. Yager (Eds.), What research says to the science teacher, vol. 3. (pp. 73-93). Washington, D. C.: National Science Teachers Association.

Richards, J. C. (1988). Mathematical visions: The pursuit of geometry in Victorian England. Boston: Academic Press.

Schwab, J. J. (1978). Science, Curriculum, and liberal education. Chicago: University of Chicago Press.

Shayer, M., & Adey, P. (1981). Towards a science of science teaching: Cognitive development and curriculum demand. London: Heinemann Educational Books.

Shymansky, J. A., Kyle, W. C., & Alport, J. M. (1983). The effects of new science curricula on student performance. Journal of Research in Science Teaching, 20, 387-404.

Silver, M. (1987). A classroom for all outdoors. Association for Interpretive Naturalists Newsletter, (October), 3.

Skoog, G. (1984). The coverage of evolution in high school biology textbooks published in the 1980's. Science Education, 68, 177-128.

Slotnick, H. B., Kerbeshian, L. A., & Heller, P. S. (1985). The implicit clinical curriculum. American Educational Research Journal, 22, 389-402.

Snyder, B. R. (1970). The Hidden Curriculum. New York: Alfred A. Knopf.

Staver, J. R., & Bay, M. (1987). Analysis of the project synthesis goal cluster orientation and inquiry emphasis of elementary science textbooks. Journal of Research in Science Teaching, 24, 629-643.

Tingle, J., & Good, R. (1989). Effects of cooperative grouping on stoichiometric problem solving and related attitudes in high school chemistry. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Francisco, CA, March 30- April 1.

Vallance, E. (1983). Hiding the hidden curriculum: An interpretation of the language of justification in nineteenth-century education reform. In H. Giroux, & D. Purpel (Eds.), The hidden curriculum and moral education: Deception or discovery? (pp. 9-27). Berkeley: McCutchan.

Welch, W. W. (1985). A science-based approach to science learning. In D. Holdzkom, & P. B. Lutz (Eds.), Research within reach: Science Education (pp. 161-170). Washington, D. C.: National Science Teachers Association.

Whitson, J. A. (1988). The politics of "non-political" curriculum: Heteroglosia and the discourse of "choice: and "effectiveness". In W. F. Pinar (Ed.), Contemporary curriculum discourses (pp. 279-330). Scottsdale, AZ: Gorsuch Scarisbrick.

Yager, R. E. (1985). In defense of defining science education as the science/society interface. Science Education, 69, 143-144.